

# FEEDLOTTING LAMBS

*A Producer's Guide*



Edited by Jenny Davis

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# Abbreviations

ADG	Average daily gain
CP	Crude protein
CW	Carcase weight
DM	Dry matter
DW	Dressed weight
EBV	Estimated Breeding Value
EMD	Eye Muscle Depth
FCR	Feed conversion ratio
g	Grams
GR	Grid reference (The GR site is a point 110 mm from the carcass midline over the 12th rib where fat is measured)
hd	Head
HSCW	Hot standard carcass weight
kg	Kilogram
LW	Liveweight
ME	Metabolisable energy
MJ	Megajoules
PFAT	Post-Weaning Fat
PEMD	Post-Weaning Eye Muscle Depth
PWWT	Post-Weaning Weight
WT	Weight
YEMD	Yearling Eye Muscle Depth
YFAT	Yearling Fat Depth
YWT	Yearling Weight

# Introduction

The industry demand for a consistent supply of lambs within set specifications has resulted in many producers having to meet forward contracts. When meeting a forward contract, or finishing lambs out of traditional seasons, grain finishing is emerging as an important management tool. Unlike the beef industry, the lamb industry has been slower to adopt feedlot practices.

One reason for not utilising feedlots has been the mixed success of finishing lambs on grain. If optimum feedlot conditions are not provided, many lamb producers find that lambs lose weight for the first few weeks on grain, and an unacceptable number of lambs die due to grain poisoning. For these reasons, together with the sometimes-low lamb growth rates, many producers do not perceive grain finishing as a profitable option. High quality pastures are the cheapest form of feed for lambs; however there are times in the year when quality pasture feed is unavailable and grain feeding is the best option to finish lambs out of season or during a drought.

This book was produced to provide producers with realistic information on finishing lambs on grain. It provides data, conclusions and recommendations based on a trial conducted at Rutherglen Research Institute that was funded as part of Department of Primary Industries (DPI) Meat program.



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# 1

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## Principles of nutrition

For successful lamb feedlotting it is essential to have a basic understanding of the sheep digestive system and principles of nutrition before moving onto planning and ration formulation. A major issue is that the sheep's rumen was designed to act as a fermentation vat in which roughage (grass, straw etc) is broken down by microbes

into volatile fatty acids, ammonia and methane. This system is beneficial for both the sheep and the microbes, as the sheep does not possess the enzymes capable of breaking down the roughage, and the microbes get to live in an ideal environment for them. However, the sheep is not designed to handle large amounts of grain.

When suddenly introduced to grain the rumen microbes will produce large amounts of lactic acid that will strip the rumen wall of tissue and cause severe metabolic stress to the sheep, which may result in its untimely death. Hence, feed-lotting sheep is an exercise in the slow adaptation of the lambs to grain, which then allows the rumen microbes to adapt to the production of lactic acid and to develop a mix of microbes that can utilise it. Rumen microbes have their particular requirements for minerals that have to be met through dietary supplementation.

### The sheep's digestive system

Sheep are ruminants, which are animals that chew their cud or 'ruminate'.

Ruminants differ from other animals in that much of their food is broken down by a process of fermentation by microbes. The sheep's stomach is divided into four chambers, of which the first two are the rumen (paunch) and the reticulum (honeycomb) (Figure 1). These two function together as a single organ (reticulo-rumen). The rumen and reticulum contain about 70% of feedstuff eaten. The rumen is

rarely filled to capacity and in sheep it usually holds 4–10 litres of feed, though the total capacity of the rumen is about 20 litres.

At birth the rumen is very small and non-functional. The abomasum, or true stomach, is well developed and equal to or even greater in size than the rumen. In the mature ruminant the rumen is 10 times as large as the abomasum. Early introduction of solid food to young ruminants allows rumen development. The fermentation of solid food produces acids, which stimulate rumen growth and enable young ruminants to eat greater quantities of solid food.

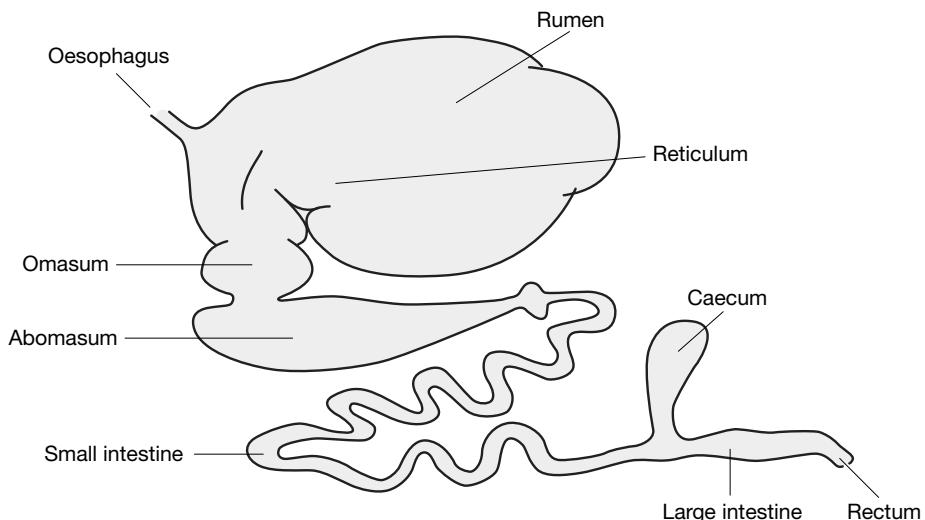


Figure 1. Digestive tract of a ruminant

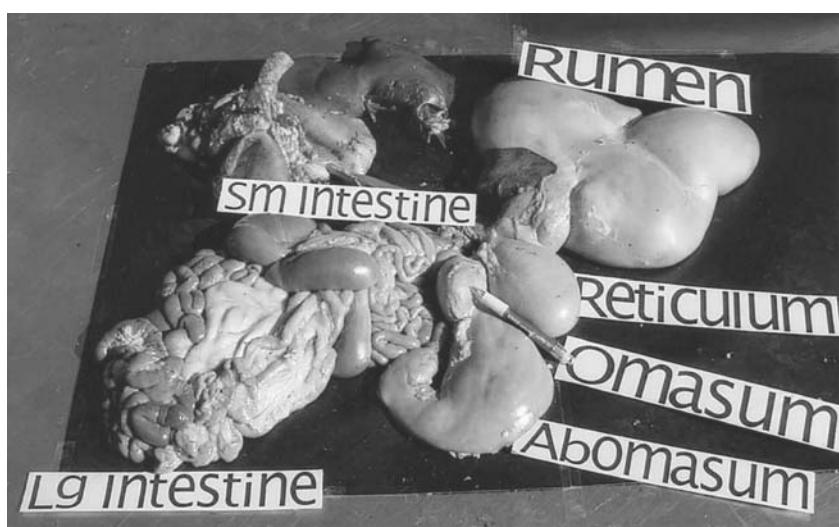


Figure 2. The digestive system

The reticulo-rumen is basically a fermentation vat that contains billions of microbes that possess enzymes capable of breaking down the bonds between the cellulose molecules in grasses and hays. The cellulose molecules are the basic building blocks of grasses and are linked together by chemical bonds that other animals, eg humans, do not possess the enzymes to break.

The most important nutritional function of the reticulo-rumen is the breakdown of protein and energy fractions of the feed into very simple molecules. The results from this fermentation are the volatile fatty acids (mainly acetic, propionic and butyric acids), methane and ammonia. The volatile fatty acids are the major source of energy for the ruminant and are absorbed through the rumen wall into the bloodstream. The microbes use the ammonia for a food source. Approximately 70% of the digestible organic matter entering the rumen is broken down by the microbes. The reticulo-rumen is a very muscular organ, constantly contracting to ensure adequate mixing of the fermenting material with the microbes and assisting in the mechanical breakdown of the feed. The size of the rumen allows feed to stay in it for a relatively long time. This means that feeds, which ferment slowly, such as hay and stubble, can be utilised.

The rumen microbes are washed out of the rumen with food particles and are digested by enzymes secreted by the animal in the lower portion of the gut. These microbes are the major source of protein to the animal.

When the sheep eats, saliva, which contains sodium bicarbonate, helps form the food into a bolus, which is then passed down the oesophagus (a tube from the mouth to the rumen) and into the rumen. A sheep produces more than six litres of saliva a day. The saliva helps neutralise the acidity caused by microbial action. By slowly adapting sheep to eating grain, the rumen microbial flora is changed gradually and lactic acid is not produced in excessive quantities. When an unadapted sheep is fed grain the bacteria in the rumen produce excess amounts of lactic acid which can literally peel off the rumen wall.

While grazing, sheep will only chew their food enough to mix the food with saliva to form a bolus to swallow. Food in the oesophagus is moved by peristaltic waves (muscular movement) and can be moved either up or down. The oesophagus is a very muscular organ. There is a ring of muscle (sphincter) at the entrance to the rumen that closes to prevent food coming up the oesophagus when the animal is grazing. Cud chewing, or rumination, is a means by which feed is regurgitated from the rumen into the mouth and re-chewed. This breaks the feed down into smaller particles giving a much larger surface area for microbial action. A large amount of gas (mainly carbon dioxide and methane) is produced during the fermentation process and must be removed by belching. A sheep can belch up to 100–150 litres of gas per day.

In the rumen, ingested feed forms a 'raft' with coarser, longer fibrous feed on top so that it can be regurgitated and re-chewed and a soup-like mixture that is found on the bottom. Dry matter content remains fairly stable in the rumen at 10–15% despite diet type. The surface area of the rumen is covered with fine projections to increase surface area for absorption. Blood vessels are in close contact with the projections to carry absorbed nutrients to the liver.

The mucosa of the reticulum has raised areas forming a honeycomb-like pattern. Once the food particles are small enough, they pass through into the omasum. The inside surface of the omasum has the appearance of the leaves of a book. The main function of the omasum is to absorb water from the broken down food (digesta), though some volatile fatty acids and ammonia are absorbed.

The fourth compartment of the ruminant stomach is the abomasum. The abomasum is connected to the omasum and is similar in function to the stomach of non-ruminants.

It secretes large amounts of gastric juices of very low pH (high acidity) and this kills off any rumen microbes and helps digest the feed. The protein entering the abomasum consists partly of feed protein, which has escaped rumen fermentation, and also the protein contained in the microbes. The pepsin in the gastric juices breaks down the protein into smaller constituent chemical parts, the peptides.

The duodenum is a short loop of the midgut and is shaped like the letter U. When digesta enters the duodenum from the abomasum the pH is very low due to the presence of gastric juices. Bile, excreted into the duodenum from the gall bladder, neutralises this acidity. From the duodenum digesta enters the small intestine. The small intestine is extremely long and has a very large internal surface due to the presence of villi, small rod-like projections.

The small intestine is the main site of absorption of the protein fractions of the feed (both microbial and feed protein). Some carbohydrate absorption also takes place in the small intestine. The contents of the small intestine are very watery. At the junction of the small intestine and large intestine, the caecum, a small blind sac, protrudes. Its function is to act as a secondary fermentation chamber to breakdown any remaining fibre and protein.

From the small intestine the digesta enters the large intestine or colon. The main function of the colon is to remove excess water from the digesta, thus concentrating the faeces. The colon contains numerous microbes and there is some secondary fermentation of undigested feed and absorption of volatile fatty acids into the blood stream.

## Digestibility of different feeds

Feeds vary greatly in both digestibility and ME. The variation in digestibility directly influences the 'rate of passage' or speed with which the food moves through the animal's digestive system. For example, a highly digestible food such as molasses will stay in the rumen for half an hour, while poorly digestible feeds such as straw will take up to 48 hours to move through the rumen. Table 1 shows approximate values of the speed of digestion of some common feedstuffs.

**Table 1. Digestibility and speed of digestion of common feeds**

	Digestibility (%)	Speed of digestion (hours)
Molasses	95	0.5
Cereal grains	85	2–6
Good grass	75	12–14
Good clover	75	18–24
Poor hay	55	30–40
Straw	40	45–55

The lower the digestibility, the longer it takes for the digestible portion of the feed to be broken down. The speed at which different parts of a feed break down also varies. For instance, grass contains a sugar-like material, which is broken down rapidly in the rumen, but the cellulose in the grass will take longer to break down. The speed of digestion will influence the amount of feed that a sheep can eat as the faster the rumen empties the more the animal can eat.

## Understanding fermentation of different feed constituents and its impact on the ruminant

### Cellulose

This is the most important nutrient in ruminant feeds, eg grass, hay, silage, straw and stubbles. Cellulose on its own is completely digestible although it does not ferment as fast as sugars and starch. Feeds such as straw and late cut hay are often of low digestibility due to a compound known as lignin. Lignin gives plants structural rigidity and protects cellulose from attack by rumen bacteria. From a practical nutritional point of view there are two aspects of cellulose fermentation that should be known and understood:

- Cellulose fermenting bacteria are very sensitive to excess acidity. They function best at a rumen pH of 6.5 to 7.0. Their growth rate is already slowing down if the pH falls to 6.2 and is completely stopped at a pH of less than 6.0.
- Cellulose fermenting bacteria are sensitive to fat and digestibility is reduced when the diet contains more than 4–6% fat.

## **Starch**

Starch is the main ingredient in cereals. The bacteria fermenting starch are distinctly different from the bacteria fermenting cellulose. They are not sensitive to acidity and ferment starch equally well at a pH of 5.5 as at a pH of 7.0. At a very low pH, such as 5.0, only a few types of rumen bacteria can survive. One type produces lactic acid, while other types ferment lactic acid further to propionic acid (a major source of energy for the sheep). If the bacteria which utilise lactic acid are not present in sufficient number, for example if cereal grains are fed to animals that are not adapted to them, then lactic acid can accumulate. If large amounts of lactic acid are absorbed, the animal becomes acidotic which is often fatal.

## **Sugars**

The bacteria that ferment sugars are very similar to those fermenting starch. When sheep are introduced to sugar diets care needs to be exercised to adapt them gradually to avoid digestive upset.

## **Protein**

Many bacteria, including those fermenting cellulose, starch and sugars, will also break down protein. Fermentation of protein yields ammonia, which is used by bacteria to form new protein in their cells. In a feedlot situation bacterial growth is generally limited by energy availability, ammonia in excess of their requirement cannot be utilised by them and is excreted in the urine as urea. To ensure optimum growth of rumen bacteria and hence the microbial protein and energy yield, the rate of ammonia release from protein should match as closely as possible the release of energy. Sources of soluble protein in the diet such as pea, vetch, or lentil screenings and good quality lucerne or medic hay can be used to provide the ammonia required to balance the nutrients required for rapid fermentation.

# 2

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## Planning and budgeting

### Planning requirements

With the increased need to supply sheep/lambs all year round to meet market specifications, feedlotting of lambs is increasing. Historically, feedlotting of lambs was only undertaken during periods of drought and other abnormal seasonal conditions.

With the intensification of any agricultural production system comes the need for legislative and regulatory requirements that ensure that environmental, animal welfare and planning concerns are met. Other issues, such as product quality, are met via standards that are upheld by industry peak councils, AusMeat and AQIS.

Prior to the construction and operation of a sheep/lamb feedlot, operators must obtain the necessary environmental and planning approvals. This applies to all feedlots irrespective of whether they are opportunity/seasonal operations or full-time/commercial operations. The time and red tape involved can be a deterrent to operators, however, without the approvals the lotfeeder has no security or legal standing and is open to prosecution on a wide range of issues.

Presently in Victoria, the local Shire is responsible for issuing all planning approvals for feedlots. For feedlots over 5000 head, a works approval also needs to be obtained from the EPA (Environment Protection Authority). In order to obtain the planning approval a collection of information needs to be presented for review. This information includes the following areas:

- Visual amenity
- Plans (location/pen/drainage/vegetation)
- Noise
- Soil
- Air
- Water
- Vegetation
- Wildlife
- Traffic production
- Effluent and waste production and disposal
- Water source and condition
- Environmental buffers
- Disposal methods of dead stock
- Economic impact
- Cleaning regimes
- Operational and construction parameters
- Contingency plans

EPA approvals are decided on a site-by-site basis, and the process will generally involve personal discussion with the local EPA representative.

## Budget

Before starting a feedlot program it is essential to do a budget. It may be more profitable to sell lambs as stores rather than finishing them on grain. It is better to discover that a feedlotting program was unprofitable prior to starting, rather than after the money has been spent. Similarly, by doing a budget the minimum sale price needed to return a profit could be calculated. Some budget considerations include:

- 1 What value are the lambs at their current weight and fat score (or how much are store lambs if they were purchased specifically for feedlotting)?
- 2 If additional labour is required, how much is it going to cost?
- 3 What is the desired growth rate of the lambs, and how long will they need to be fed?
- 4 How much is the feed going to cost?
- 5 What is the additional cost of animal health products, such as an extra drench and vaccination?

- 6 If you do not have feedlot equipment how much will it cost to buy?
- 7 Do the lambs need to be shorn? How much will it cost?
- 8 What price will you get for the lambs after they have been finished in the feedlot?
- 9 What percentage of animals may die or not finish?

Calculate the profit or loss if the lambs were fed at a starting liveweight of 35 kg and finished at 46 kg.

An example gross margin is given in Table 2. The following assumptions are made based on data from the Rutherglen Research Institute trial (conducted in 2000 – see Chapter 5):

- Lambs started at 35 kg need to put on 11 kg of liveweight to make export market specifications (minimum 22 kg carcase weight).
- Lambs will eat on average 7 kg of a standard feedlot ration to put on 1 kg of liveweight gain. Therefore they will require 77 kg of feed.

**Table 2. Lamb feedlot gross margin analysis (\$/hd)**

Example		Your estimate	
<b>COSTS</b>	<b>\$/hd</b>	<b>COSTS</b>	<b>\$/hd</b>
Value of lambs as stores	\$48.00	Value of lambs as stores	_____
Transport to property*		Transport to property	_____
<b>Feed costs:</b>		<b>Feed costs:</b>	
Start up ration (15 kg at \$157/tonne)	2.36	Start up ration ( ___ kg at \$ ___ /tonne)	_____
Finishing ration (77 kg at \$160/tonne)	12.32	Finishing ration ( ___ kg at \$ ___ /tonne)	_____
<b>Variable costs:</b>		<b>Variable costs:</b>	
Drench	0.27	Drench	_____
Vaccination	0.16	Vaccination	_____
Shearing	2.92	Shearing	_____
Deaths (2% at \$48/hd)	0.96	Deaths ( ___ % at \$48/hd)	_____
Culls (5% at \$48/hd)	2.40	Culls ( ___ % at 48/hd)	_____
<b>Total costs (A)</b>	<b>\$68.39</b>	<b>Total costs (A)</b>	_____
<b>RETURNS</b>	<b>\$/head</b>	<b>RETURNS</b>	<b>\$/head</b>
Finished lamb (22 kg DW at \$3/kg)	66.00	Finished lamb (22 kg DW at \$ ___ /kg)	_____
Skin	14.00	Skin	_____
<b>Total returns (B)</b>	<b>80.00</b>	<b>Total returns (B)</b>	_____
<b>Gross margin per head (B-A)</b>	<b>\$10.61</b>	<b>Gross margin per head (B-A)</b>	_____

\*If purchasing store lambs

- Average daily gain is 261 g.
- There will be a 2% mortality rate.
- Five per cent of lambs will be shy feeders and will not make market specifications.
- Store lambs are valued at \$48 per lamb.
- Finished lambs are valued at \$3/kg DW (ie \$66/lamb) with an extra \$14/lamb for skin.
- Transport and marketing costs are the same whether the lambs are sold as stores or finished lambs.

Use Table 2 to record your own costs and the prices for lambs. Below is a sensitivity analysis showing the effect lamb price and skin value have on the gross margin per head. Using the above assumptions, prices less than \$2.50/kg carcase weight result in a loss, regardless of the skin value.

**Table 3. Gross margin (\$/hd) based on variable carcase prices and skin values at sale**

Carcase price (\$/kg)	Skin value (\$/hd)					
	4.00	6.00	8.00	10.00	12.00	14.00
2.00	-21.39	-19.39	-17.39	-15.39	-13.39	-11.39
2.50	-10.39	-8.39	-6.39	-4.39	-2.39	-0.39
3.00	0.61	2.61	4.61	6.61	8.61	10.61
3.50	11.61	13.61	15.61	17.61	19.61	21.61

Feed price and feed conversion ratio (FCR) also have a large effect on gross margin per head. FCR is the amount of feed a lamb eats to put on a kilogram of liveweight gain (ie if a lamb eats 6 kg of feed and puts on 1 kg of liveweight then its FCR is 6:1).

Table 4 provides a sensitivity analysis for producing a 22 kg carcase with different FCR and grain prices. The lambs in the Rutherglen Research Institute trial averaged 7.3:1 for FCR. With experience and improved management techniques the ratio may drop to 5.0:1, which would make a substantial difference to the gross margin analysis.

**Table 4. Gross margin (\$/hd) based on variable FCR and cost of ration**

FCR	Cost of ration (\$/tonne)				
	160.00	180.00	200.00	220.00	240.00
5:1	14.13	13.03	11.93	10.83	9.73
6:1	12.37	11.05	9.73	8.41	7.09
7:1	10.61	9.07	7.53	5.99	4.45
8:1	8.85	7.09	5.33	3.57	1.81
9:1	7.09	5.11	3.13	1.15	-0.83

Growth rate will have a large effect on gross margin per head, as it will change the length of time that the lambs must be fed. Below is a sensitivity analysis for producing a 22 kg carcase with different growth rates and grain prices. The assumption was made that lambs ate 1.9 kg of feed a day (this is based on the data from the Rutherglen Research Trial). The length of time that the lambs are on feed is determined by growth rate. For example, to achieve a liveweight gain of 11 kg, lambs growing at 100 g/day will take 110 days as compared with 31 days when growing at 350 g/day.

**Table 5. Gross margin (\$/hd) based on variable lamb growth rates and cost of ration**

Growth rate (g/day)	Cost of ration (\$/tonne)				
	160.00	180.00	200.00	220.00	240.00
100	-10.51	-14.69	-18.87	-23.05	-27.23
150	0.43	-2.38	-5.19	-8.00	-10.81
200	6.21	4.12	2.03	-0.06	-2.15
250	9.55	7.88	6.21	4.54	2.87
300	11.68	10.28	8.87	7.46	6.06
350	13.51	12.33	11.15	9.97	8.79

Calculating your estimated returns and sensitivities will help you to determine if it is worthwhile finishing lambs in a feedlot. There is always risk involved in finishing lambs on grain due to deaths, shy feeders and unexpected changes in weather or market prices. To maximise profitability, all these risks need to be assessed and budgeted for in the planning phase. Forward contracts can be used to minimise financial risk.

## Purchasing feeder lambs

If the lamb feedlotter does not breed their own lambs, then feeder lambs need to be sourced from the market. There are several new and innovative arrangements to determine a 'fair' purchase price for feeder lambs. Just like the cattle industry, lamb feedlotters are recognising the extra value that high performing lambs offer their enterprises. Lamb breeders who are using superior genetics and are managing their lambs for maximum feedlot performance (which includes marketing them at the right fat scores) deserve to be rewarded for their efforts.

This has resulted in some lamb finishers moving into 'Breeder/Finisher' alliances where they pay a price for the feeder lambs that directly relates to the performance of the lambs in the feedlot. Tools such as this require good relationships between all parties, but are excellent ways of ensuring that the lamb feedlotter receives high performing lambs, at an equitable price.

Feedlotters who finish lambs they have bred have an invaluable source of feedback. The collection of information on growth rates and carcase traits is of great importance to a successful breeding program.

## Which market to target and its suitability for lot feeding lambs?

There are a number of markets available for prime lamb producers to target. Not all of these markets will be suitable for lot-fed lamb. In most cases producers who are contemplating opportunity feeding of lambs will be targeting the export market, however, there may be some producers who are targeting the heavy trade or food service markets. While there is some overlap in the carcase weights that each of these markets accepts, there is a continuing trend to move towards heavier carcase weights. This gives the processor the flexibility to break carcasses to primal cuts or beyond such as in export markets and the food service industry.

### Trade lambs 'Supermarket lambs'

Lambs at 17–22 kg, fatscore 2–3 are the most common specifications sought by buyers. Due to the relatively low carcase weights this market generally doesn't lend itself towards lot-fed lambs. Another challenge for producing lambs for this market is to gain forward contracts, as generally forward contracts are not easily available for lightweight lambs.

### Heavy trade lambs

Lambs that are 18–22 kg, fatscore 2–3 are preferred by more progressive retailers as well as supermarkets who produce value added lamb products, such as Trim Lamb. This market has exacting specifications and demands carcases that offer versatility and a range of options for the processor. Fat score is critical, with processors preferring lambs that are between 7 and 12 mm. Providing lambs are not over fat (greater

than 12 mm) when entering the feedlot it is feasible for producers to lot feed lambs for this market. Producers who are not involved with an alliance may find it difficult to obtain forward contracts for this market.

### **Food service**

Lambs that are 22–25 kg, fatscore 2–3 are preferred, with 15 mm (high fatscore 3) the absolute maximum. The lamb type preferred by the high value food service operators, such as restaurants, is lean and high yielding with a high degree of emphasis on consistency of product. Forward contracts, again, may be difficult for the opportunity lot feeder to obtain, however they are obtainable, especially for out-of-season lambs.

### **Export**

Lambs that are 20–30 kg, fat 6–20 mm lambs are preferred with some processors accepting a low percentage of fatscore 5 (greater than 21 mm) – check with the processor or your agent. The major lamb export processors regularly offer forward contracts for lambs enabling the producer to estimate returns. The highest value end of this market is the North American segment. This market demands high value prime cuts, such as racks and loins, and that these products are within close specification. Due to the desire of this market for uniform product, the fact that forward contracts are available and the demand for high weight carcasses, it lends itself well towards opportunity lot-fed lambs.

### **Forward contracts and estimating returns**

Whilst lot feeding lambs does provide the ability to produce lambs that are highly uniform in weight and fatscore there are risks involved. The possibility of lower than expected growth rates or animal health complications are risks that can be overcome. Another is the risk of returns for lambs not being enough to make the exercise worthwhile.

One way around this problem is to forward sell, or ‘contract’ the lambs. This system of marketing enables the producer to know what they will receive for the lambs before they start feeding them and as a result provides the opportunity to budget. When combined with an expected cost of production, forward contracting the lambs enables producers to lock into a price that will give them a positive return, providing the market is offering enough. Currently there are no other marketing systems that offer this level of security. When combined with an accurate and realistic budget at the start of feeding, and close monitoring of the performance of the lambs within the feedlot, forward contracts give the opportunity lot feeder the ability to safely determine if they will make money.

Another consideration of the lot feeder is how they are going to get feedback on lambs they sell. Through gaining feedback on carcase weight and fatscore, and

where possible, lean meat yield, it is possible to review the feeding system that is used as well as the genetic suitability of the lambs for the chosen market.

Do not plan to 'sell' your lambs when they are finished, but make a deliberate decision to 'market' them. There are some distinct differences between the two approaches.

A phone call from a 'seller' to his processor might go something like this:

*'G'day, we haven't spoken for a while but I thought I would give you a call as I've got some lambs to sell. They have been in my feedlot for six weeks, there are about 450 of them, I'd say they are about 47 kg and they should be ready next week. What do you think they are worth?'*

Alternatively a 'marketeer's' phone call might be more like this:

*'G'day Brent, look I just thought I'd give you a call to discuss what I'm planning to do this summer. I've got 450 lambs that are all by high index LAMB-PLAN rams that I want to feedlot on grain. I costed out a ration of some triticale, lupins and lucerne that I purchased this harvest, I figure with a few extra costs and the grain it's going to cost me \$23 per head to get them to 47 kg by early March. If I can get \$2.90/kg carcase weight then I think it is worth going ahead with, what are your thoughts on that as a price?'*

Marketing requires a customer focus that is profit orientated. This is quite different to the traditional 'selling' system where the focus has been on what can be produced, rather than what the customer needs. The variable nature of market prices means that in some instances the 'spot' market price may rise above your contracted price, however, long-term averages indicate that a close relationship with a processor will lead to the best returns, with minimised risks and greater security.

# 3

## Feedlot design

### Feedlot site

The feedlot should be sited on a well-drained area with ample shade, sheltered from the sun and wind, free from dust, and away from sources of frequent disturbance (eg roadways, dogs etc). Siting the feedlot close to yards will reduce weight loss through less movement and allow easy access for health and weight checks. To aid drainage, a slope of about  $3^\circ$  is ideal, as erosion may be a problem if the slope is any



Figure 3. Good ground is essential for the comfort of lambs, especially after heavy rain

steeper. Soil type needs to be considered as heavy soils may become too muddy and predispose lambs to disease while sandy soils may be prone to erosion. Protect trees in the feedlot because sheep will ringbark them.

## Water supply

A clean water supply is required and water troughs should be cleaned daily. Lambs will avoid drinking dirty water and will decrease feed intake. Water troughs should be placed well away from feed troughs, to avoid grain contamination of the water. Because of contamination and risks of lambs being bogged, dams are not recommended for feedlots.

The average water requirement of feedlot lambs is about four litres per day. This will vary depending on the time of year, amount of shade and the ration being fed. In prolonged hot weather water consumption has been recorded to be as high as nine litres per day, and provision should be made to supply this amount. Recharge rate is more important than size or length of a trough and should be rapid to ensure that water is always available in the trough.

## Feedlot size

Feedlot size is determined by the number of lambs to be fed. The industry recommendation is for a minimum of approximately five square meters of yard space per



Figure 4. Adequate shade and a shaded water trough are essential during the early introduction period

lamb. For example, to feedlot 500 lambs, an area of 2500 square metres, or a quarter of a hectare is required. There is anecdotal evidence (Geoff Duddy, personal communication) that 10 square metres per lamb is preferable as social stress, which is a big factor with growth rates, shy feeders and feed conversion efficiency, is less at this space allowance. Rectangular yards allow better separation of feed and water points. The preferred mob size is 300–400 lambs per pen.

## Environmental enrichment

To alleviate boredom of lambs under feedlot conditions suspended chains may be used. Other pieces of equipment such as tyres, timber and flexible PVC have been used in a goat feedlot and have resulted in improved growth rates.

## Feeding equipment

To obtain optimum growth rates and reduce the risk of digestive problems, feed should be available at all times. Feed refusals and wet feed should be removed daily. Mixing the grain and roughage portions of the diet together reduces sorting of feed by lambs and helps prevent animals gorging on grain. Use of pellets that combine grain and roughage eliminates sorting totally and may result in consistent growth rates. When hay is fed separately, hay-racks or rings should be used to prevent waste. A simple hay-rack can be made from 10 cm square mesh held up by steel posts.

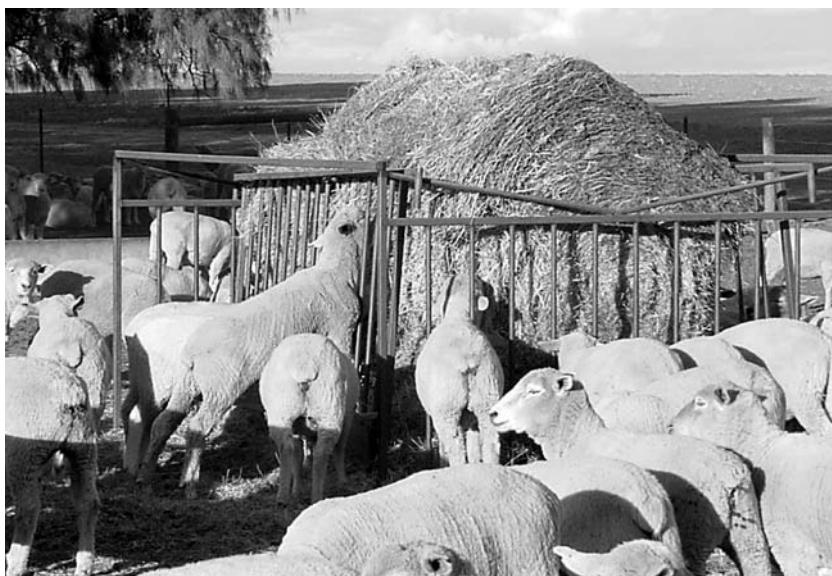


Figure 5. A simple farm-made hay-rack

## Self-feeders

Self-feeders may be used but the hay will have to be fed separately as it will get caught at the outlet and obstruct feed flow. When fed separately, hay must be of high quality otherwise some lambs will avoid it and only eat grain, which will lead to digestive problems. Self-feeders need to have the capacity to hold enough feed to last between feeding periods; even short periods of no feed may cause grain poisoning in lambs due to gorging when feed is reintroduced. Allow 10 cm of trough space



Figure 6. There are many brands of commercially available feeders that are suitable for use in a lamb feedlot



Figure 7. Feeder height is critical to avoid feed trampling and spoilage by lambs

per lamb with self-feeders (ie 10 lambs/metre). Using self-feeders does not negate the necessity of checking the feeders each day. Any wet feed or manure contaminated feed should be removed daily.

When placing feeders in a paddock, it is important to align them east–west so that one side is always in the shade in the hot part of the day. Lambs do not like to eat from the troughs if the metal is too hot. Feeders should be positioned up slope and throughout the pen.



Figure 8. Keeping a couple of extra pens is ideal for improving pen condition after sudden heavy rain



Figures 9. A simple farm-made self feeder

## Open troughs

Feed troughs can be simple and inexpensive but need to be constructed so that lambs cannot stand in them and dirty the feed. Covering the troughs will protect grain from spoilage by rain. When sheep are fed daily, 15 cm of trough space per sheep needs to be provided. For example, 400 lambs need 40 m of trough space when self-feeders are used and 60 m when troughs are used.



Figure 10. Daily feeding of lambs requires sufficient trough space



Figure 11. Daily feeding of lambs requires sufficient trough space

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# 4

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## Rations

Lambs need a high energy and protein ration to grow rapidly. To ensure sufficient protein, a minimum level of 15% crude protein (18% maximum) is recommended. Once protein needs are met lambs will respond to increasing energy concentration in the diet by increasing growth rates. As protein meal usually costs more than cereal grains, many feedlots will add a proportion of urea to the ration to save money. Urea is a source of non-protein nitrogen that the rumen bacteria can use effectively instead of protein thereby reducing their requirements of true protein.

The energy content of feeds is described in terms of megajoules of metabolisable energy per kilogram of feed dry matter (MJ ME/kg DM). Table 6 gives the average energy and protein contents of the commonly available feedstuffs. To ensure growth rates of over 200 g/day the ME level of the ration should be higher than 10.5 MJ/kg DM. When formulating a ration for feedlotting lambs, the individual components should be analysed to ensure that the ration meets the protein and energy requirements of the lamb. It is too risky to just assume that average values apply.

Feedstuffs may be evaluated by sending a sample to a reputable laboratory. They will analyse the crude protein, metabolisable energy, digestibility, fibre and dry matter (DM) content of the feed. The details of testing laboratories can be obtained from your local Department of Agriculture.

**Table 6. Nutritive values of common feeds**

Feed type	Energy (MJ/kg as fed)*		Protein (% Crude protein)	
	Average	Common range	Average	Common range
Wheat, Triticale, Maize	12	11.5–12.5	11	9–15
Barley	12	11.5–12.5	10	8–14
Lupins	12	11.5–12.5	32	28–36
Peas	12	11.5–12.5	24	20–27
Oats	10	9–11	9	6–12
Canola meal	12	11–14.8	39.5	32–42
Cottonseed meal	11.1	9.6–12.7	43.2	39–48
Sunflower meal (mech-extd)	9.5	8–10.1	35.6	31–39
Sheep pellets (brands vary)	10	9–11	12	8–20
Cereal silage	9	8–10	8.5	5–11
Lucerne silage	9	8–10	18	15–22
Lucerne hay	8.5	7–9	20	16–25
Clover hay (early)	8.5	7–9.5	18	15–20
Pasture hay (mid-season)	7	6–7	11	8–16
Oaten hay	7	6–8	8	5–10
Grass hay	6	5–7	8	5–10
Cereal straw	5	4–6	4	3–5

\*Approx. 90% dry matter, except hay/straw at 85% DM and silage at 45% DM

## Cereal grain

Cereal grains are usually the cheapest form of energy and supply some protein. Grains usually comprise between 65% and 85% of the finishing ration. Lambs differ from cattle in their ability to chew their food and there is no economic advantage in processing (rolling, flaking or cracking) grains for lambs. Cereal grains are high in phosphorus and need to be supplemented with calcium carbonate (use limestone at 1% in the ration) to balance the calcium/phosphorus ratio.

The primary carbohydrate of cereal grains is starch. Cereal grains differ greatly in their starch content, with wheat and corn having the highest starch content (average 76% starch) followed by barley and oats (average 61% and 42% starch respectively). The rate and extent of starch fermentation in the rumen differ greatly between grains and varieties of grains. Generally, wheat and barley are more rapidly fermented by rumen microbes than are maize and sorghum. Oats have the lowest starch level of cereal grains yet oat starch is fermented the fastest. It is the amount of starch and its speed of digestion in the rumen that leads to acidosis. Table 7 shows the rate of fermentation and digestion of different cereal grain by ruminants.

**Table 7. The fermentation and digestion of starch from different cereal grains by ruminants\***

	Maize	Sorghum	Barley	Wheat	Oat
Starch content (% of dry matter)	76	75	61	76	42
Starch digested in the rumen (% of intake)	76	64	87	89	92
Starch solubility in the rumen (%)	26	32	54	68	96
For each kg DM consumed starch intake (g/day)	760	750	610	760	420
Starch fermented in the rumen (g/day)	578	480	531	676	386

(\*data sourced from: Rowe & Pethick 1994)

Another important cereal grain for lamb feedlotting is triticale. Triticale has a higher dietary fibre content compared to wheat (40% higher, mainly because of non-starch polysaccharides such as cellulose). Triticale tends to be less digested in the rumen and passed more into the small intestine to yield glucose that can be used directly by the lamb for energy.

All cereal grains are useful for feedlotting. Wheat has the highest risk of digestive upsets because of its high starch and low fibre content while oats have the lowest due to their low starch and high fibre content. Oats vary greatly in protein and energy content. Grain poisoning can occur when different batches of grain are used and so it is necessary when changing grains or batches to do so slowly. Ideally, buy 100% of your estimated requirements at the outset of feeding to avoid ration changes.

## Grain legumes

Legume grains are high in metabolisable energy but the nature of carbohydrates and rate and pattern of fermentation of legumes differ from cereal grains. The lower starch and higher fibre content make legumes safer to feed than cereal grains but the high crude protein content leads to inefficient fermentation with high levels of nitrogen being excreted in the urine if legumes are fed at a level greater than 30% in the ration. Legumes are ideal to increase the crude protein content in a mainly cereal grain ration.

In cereals the main storage carbohydrate is starch, and fibre is generally part of the cell wall structure. Legumes such as lupins, peas and faba bean have less storage starch and have fibre as part of the energy storage material as well as the structural material. For example, lupin contains less than 10% starch while peas and faba beans contain 48% and 37% starch. The percentage of total fibre for lupins, peas, and faba bean is 20%, 9%, 11% respectively compared with 6.6% for barley. Starch is rapidly fermented in the rumen leading to acidosis in unadapted animals, therefore the lower levels of starch in legumes make them a safer feed for unadapted lambs than the cereals.

## Meals

Like the legume grains, oilseed meals are high in both protein and energy, however their cost restricts their use in feedlot rations to minimal amounts necessary to increase the protein content of the total ration. The more commonly available meals are canola, cottonseed and sunflower.

## Urea

Urea is used to increase the nitrogen content of a grain ration. Commercial grade urea contains 46% nitrogen. Rumen bacteria can use nitrogen as a protein source and so adding 1% urea to a ration is equivalent to increasing the protein content of the ration by 2.87%. The maximum amount of urea to use is 1.5% (ie 15 kg per tonne). **Urea is very toxic and using more than this amount could kill a large number of lambs.** It is also very toxic to non-ruminants such as horses, pigs and poultry, so it is not advised to feed any surplus feed containing urea to these animals.

When adding urea to a ration, ensure that it is mixed in well with the grain and that there are no lumps of urea visible. Do not use urea that has gone lumpy with dampness as this will clump in the ration and may cause fatalities.

## Salt and limestone

Significantly improved feed conversion and growth rate in lambs will result from the inclusion of salt and limestone in the diet because grains are low in calcium, and salt will increase water consumption and feed intake. Ground limestone (calcium carbonate) should be added at the rate of 1.0–1.5% by weight to the ration and salt at a rate of 1.5% by weight.

## Sodium bentonite and sodium bicarbonate

Sodium bentonite and sodium bicarbonate are used in rations to reduce the likelihood of acidosis. They do not prevent lactic acid production but provide a buffer to moderate the changes in acidity. Current recommendations are to add 2% bentonite and 0.5 to 1% bicarbonate to the ration at the start of the feeding period. The level of bentonite can be reduced over the feeding period to 1% or nil.

## Roughage

Lambs need roughage to ensure the efficient functioning of their digestive tract. Roughage, depending on its quality, should comprise 10–30% of the finishing ration. If straw is used it should only be included as 10% of the ration as it will markedly decrease the energy content of the ration. If feeding roughage separately,

straw is not recommended, as the lambs will not consume sufficient for their needs. Good quality hay (having a minimum ME content of 9 MJ ME/kg DM) can be included up to 30% of the ration. High quality silage can also be used as roughage in lamb feedlots. When starting lambs on feedlot rations, high quality hay or silage should be used to encourage the lambs to start eating.

## Silage

Silages have a lower energy content than cereal grains and therefore lamb growth rates achievable on silage rations are lower than that on rations based on cereals. For example, trials run by Peter Holst from the NSW Department of Agriculture have shown that lucerne silage (ME 10.1 MJ/kg DM; CP 18.3% of DM) when fed alone to second-cross lambs produced a liveweight gain of 145 g/day. When a grain mixture of 74% barley and 26% lupins was offered with '*ad lib*' silage, growth rates increased in proportion to the amount of grain in the ration so that when the lambs were consuming almost a kilogram of grain their growth rates were 270 g/day. Oat silage (ME 9.5 MJ/kg DM; CP 14.8% of DM) as the sole ration produced liveweights gains of 3 g/day and with 40% grain produced liveweight gains of 130 g/day.

The proportion of silage in a ration will depend on the relative costs and quality of grain and silage. The higher the proportion of silage in the ration the longer the lambs will take to achieve market weights. Silage can be quite variable in metabolisable energy and it is necessary to have it tested before use.

## Pellets

Pellets are very convenient and easy to use. Their value will depend on their formulation. When buying pellets for finishing lambs attention has to be paid to the protein and energy content of the pellet. The pellet should contain a minimum of 14% protein to ensure that the protein requirements of the lambs are met. If the ME is high (11 MJ ME/kg DM and higher) care has to be taken when introducing the lambs to the pellets as grain poisoning could occur in unadapted lambs. If the pellets are too processed additional fibre will have to be supplied separately. Once the protein requirements of the lambs are met then lamb growth will respond to energy. The higher the energy in the pellet the higher the lamb growth. Feeding pellets with an energy content of 10 MJ/kg DM will result in lamb growth of 200 g/day or less. To achieve higher growth rates (200 g/day or more) pellets should contain greater than 10.6 MJ/kg DM. If the pellets are not balanced for minerals then additional minerals will need to be supplied. There have been cases of pellets causing urinary calculi.



Figure 12. A lamb affected with urinary calculi (or water belly) due to lack of calcium in the diet

## Preparing the ration

If there are no scales on the feed delivery wagon calibrate the auger by running it for a minute and then weighing the grain. This gives the amount of grain augered per minute. Calculate how many minutes needed to run the auger to make up the ration.

Hay can be mixed with the grain or fed separately. Grain should be fed whole as any gain made by the small increase in digestibility due to rolling or hammer-milling is nullified by the cost of this process. Mineral or urea supplements should be added and mixed with the grain to ensure even distribution through the ration.

## Ration formulation

Below is an example on how to calculate the energy and protein levels of a final ration using one of the rations fed in the Rutherglen Research Institute (RRI) trial.

The control ration (Table 8) contained 46.5% oats, 25.5% triticale, 25.0% lupins, 2% bentonite and 1% bicarbonate. The triticale had an energy level of 12.7 MJ ME/kg DM and 15% crude protein. To estimate the protein level contributed by the triticale, multiply the crude protein percent by 25.5% which results in 3.83% of crude protein.

$$\begin{aligned} \text{ie Crude protein contributed by triticale} &= 15 \times 25.5\% \\ &= 3.83\% \end{aligned}$$

Similarly for the crude protein contributed by the lupins =  $31.4 \times 25\% = 7.85\%$ . When the contributions from all the ration components are added (oats, triticale and lupins) the ration contains 15.2% crude protein. The same calculations are made for the energy content. Bentonite and bicarbonate do not contribute either to the energy or protein content of the ration but are added as aids against acidosis.

**Table 8. Ration composition for the control diet in the RRI case study**

Component	ME (MJ/kg DM)	% Crude protein	% Feedstuff in ration	ME in ration	% CP in ration
Triticale	12.7	15	25.5	3.2 ( $12.7 \times 25.5\%$ )	3.8 ( $15.0 \times 25.5\%$ )
Oats	10	7.6	46.5	4.6	3.5
Lupins	12.3	31.4	25	3.1	7.8
Bentonite	0	0	2	0	0
Bicarbonate	0	0	1	0	0
<b>TOTAL</b>			<b>100</b>	<b>10.9</b>	<b>15.2</b>

In short term feedlot operations, the percentage weight of each ingredient calculated on a dry matter (DM) basis could usually be considered the same as that calculated on an actual weight basis. However, for long-term operations, or for those feed components with very different DM percentages, significant improvement in accuracy and savings will result from converting percentages from a DM basis to an actual weight basis.

**Table 9. Converting feed from a dry matter basis to an actual basis**

Ingredient	% in Ration DM	% DM in ingredient	Actual kg in final ration	Actual % in final ration
Triticale	25.5	90.9	$25.5/(90.9/100) = 28.05$	$(28.05/109.11) \times 100 = 25.71$
Oats	46.5	91.6	$46.5/(91.6/100) = 50.76$	46.53
Lupins	25	91.6	$25.0/(91.6/100) = 27.29$	25.01
Bentonite	2	100	$2/(100/100) = 2$	1.83
Bicarbonate	1	100	$1/(100/100) = 1$	0.92
<b>TOTAL</b>	<b>100</b>		<b>109.11</b>	<b>100</b>

Table 9 shows the actual quantity of triticale and other feedstuffs remains essentially the same when the dry matter is 90% and above. However if silage at 46% DM replaced lupins in the ration the actual percentage in the final ration would be 40.4 to compensate for the variation in dry matter between the two feeds. The figures on which to base these calculations are obtained from a feed analysis report that is recommended for any feed to be used in a feedlot as previously discussed.

## Starter ration

Lambs must be introduced to grain slowly to allow the rumen microbes time to adapt. Failure to do this can result in acidosis (grain poisoning). There are several ways to adapt lambs to grain. All will take at least 14 days before the lambs are on the final ration. One method is to feed the lambs chopped roughage in troughs until all lambs are eating. Once lambs are eating then grain is gradually introduced with the roughage (Table 10).

**Table 10. Introducing grain into a ration**

Day	Concentrate %	Hay % (chopped and mixed)
Until all lambs feeding	0	100
2–4	20	80
5–7	40	60
8–10	50	50
11–13	60	40
14 +	70	30

If the lambs are to be fed using self-feeders with hay fed separately then commence feeding 50 g of grain per head per day either trailed on the ground or in a trough. Feed daily, increasing the grain portion of the ration by 50 g/day until the lambs are eating 650 g/day. Once lambs are accustomed to this ration they can be fed from the self-feeders. Ensure that they have had a feed of hay before being allowed to eat from the self-feeders for the first time. Lambs can be introduced to feed by trailing grain on the ground for two weeks prior to them coming into the feedlot.

# 5

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## Selection and preparation of lambs

### Factors to consider in selection of lambs for the feedlot

The ideal lamb for feedlotting is a second-cross lamb, 35 kg minimum liveweight, with a fat score of 2 to 2.5 (6 to 8 mm fat cover at the GR site).

When selecting lambs for a feedlot, factors to consider are:

- genetics (both breed type and genetic merit as evaluated by LAMBPLAN figures)
- freedom from disease
- structural soundness
- starting weight – 35 to 45 kg; cull lambs which are poor doers as they will never perform well in a feedlot situation
- fat score – 2 to 2.5
- sex – at the same heavy liveweight (45–50 kg), ewe lambs will usually be a fat score fatter than wethers.

### Genetics

Second-cross lambs can be expected to grow faster than most first-cross and purebred lambs due to greater hybrid vigour. First-cross lambs (Border Leicester × Merino) will perform better than purebreds (eg Corriedales, Bonds and Merinos), which generally return less at a similar weight and fat score than second and first-

cross lambs. This price differential is related mainly to carcase conformation. Second-cross lambs have a greater proportion of their yield in the higher priced cuts such as the loin and hindquarter compared to first-cross lambs and purebred Merinos.

In recent years the breed structure of the Australian prime lamb industry has changed and a number of composite breeds are now used for production of prime lambs. A composite breed, which has been bred with emphasis on selection for weight, muscle and leanness will also produce lambs which are suitable for feedlotting.

The final market destination has an impact on breed preference. Although second-cross lambs are preferred on the domestic Australian market, there is a demand for live lambs or carcases from first-cross lambs (Terminal sire  $\times$  Merino and Maternal sire  $\times$  Merino) and purebred lambs, such as Merinos, to some Middle Eastern markets.

When deciding on the best breed for feedlotting lambs for the export market, it is important to know the final market destination of the product. Check with the exporter for their breed preference. They will have good information available on the breeds and types of lambs that perform well in a feedlot and that will meet their processing specification and may even be able to refer you to a store lamb producer (if you are buying in).

## Preparation of lambs

Before entry into the feedlot, lambs require preparation. The following activities need to be performed: vaccination, drenching, shearing and an introductory period on grain. Lambs should be free of disease; in particular, pink eye, scabby mouth or lameness.

### Vaccination

Vaccinate all lambs with a 6-in-1 vaccine a week before entry into the feedlot regardless of whether they have been vaccinated at marking or weaning. High grain diets can predispose lambs to pulpy kidney (enterotoxaemia).

### Parasites

Before entry into the feedlot, all lambs should be drenched with an effective broad-spectrum anthelmintic drench.

## Shearing

Shearing lambs two or more weeks before they enter the feedlot can improve feed intake, increase hide values and reduce flystrike risks. At least six weeks of wool is required to obtain a reasonable return on skins. Lambs on high grain diets frequently have loose faeces in the first few weeks and are therefore more susceptible to flystrike. Chemical treatment of flystrike may not be possible in feedlot lambs as the treatments have long withholding periods that can affect marketing time.

If feedlotting during warmer months (September–April), shear lambs. When feedlotting in winter (May–August), do not shear as cold weather and rain can reduce feed intake and increase time in the feedlot.



# 6

## Monitoring of lambs

Regular monitoring of lambs for production and health status is critical for successful feedlotting of lambs.

### Weighing and fat-scoring lambs

It is essential to weigh lambs regularly to monitor weight gain. If possible, weighing should be carried out at the same time each day to avoid weight variations caused



Figure 13. Regular monitoring of liveweight gain is important in feedlot management

by differences in gut fill. If this is not practical then fast lambs for two to three hours before weighing to reduce this variability.

Weighing and fat-scoring lambs during the feedlotting period and prior to marketing (especially when selling by contract) reduces the risk of supplying lambs outside the contracted specifications. This especially applies when selling over a grid, when price penalties for supplying lambs outside of required specifications might apply. If lambs are to be sold over the hooks, those that are fat score 5 may receive a significant price discount, and should be identified PRIOR to being outside of specifications and managed accordingly.

Fat scoring is best monitored at the GR site (located 110 mm from the backbone of the sheep on the twelfth rib) which is where fatness is measured by the processor. Contact your local Department of Agriculture for more information about this technique.

### **Shy feeders**

Generally, 5 to 10% of lambs will not adapt to the feedlot situation and should be removed from the feedlot as soon as they are identified. Shy feeders are reluctant to come to the feed trough and therefore lose weight. Either sell the shy feeders or place them on pasture or fodder crop to finish. Some producers will separate shy feeders and put them in a feedlot pen by themselves. When fed separately, some animals will adapt to grain but there will be a proportion that never will. These animals inevitably end up costing the producer money through poor performance.



Figure 14. Healthy lambs are alert to their surroundings

## Animal health

Producers must be able to recognise and manage disease and digestive problems when feedlotting lambs. If a disease persists, advice should be sought from the local veterinarian or an officer of your local State Department. When selling animals after any treatment, ensure that the withholding period applicable to the medication is observed. All markets are highly sensitive to chemical residues in meat. Common diseases include:

### Grain poisoning (acidosis)

The animal controls rumen acidity during eating and rumination by secreting saliva, which is alkaline and neutralises the acid formed in the rumen. The quantity of saliva secreted depends largely on the length of time spent eating and ruminating, as this is the time when saliva production is greatest.

The amount of acid produced from fermentation is directly proportional to the digestibility of the feed. Therefore only about half the acids are produced from fermenting straw compared to the same weight of cereals. Because the feeding of grain requires less chewing and rumination time, the animal produces less saliva when fed cereal grain than when fed straw. The resultant effect is that if large amounts of cereal grains are fed to lambs, the rumen pH will drop to about 5.2 to 5.4 (ie it becomes very acidic). This will result in acidosis. In adapted animals the mix of rumen microbes changes so that the lactic acid that is produced is utilised. Ensuring that the lambs are adapted to grain slowly and by providing adequate

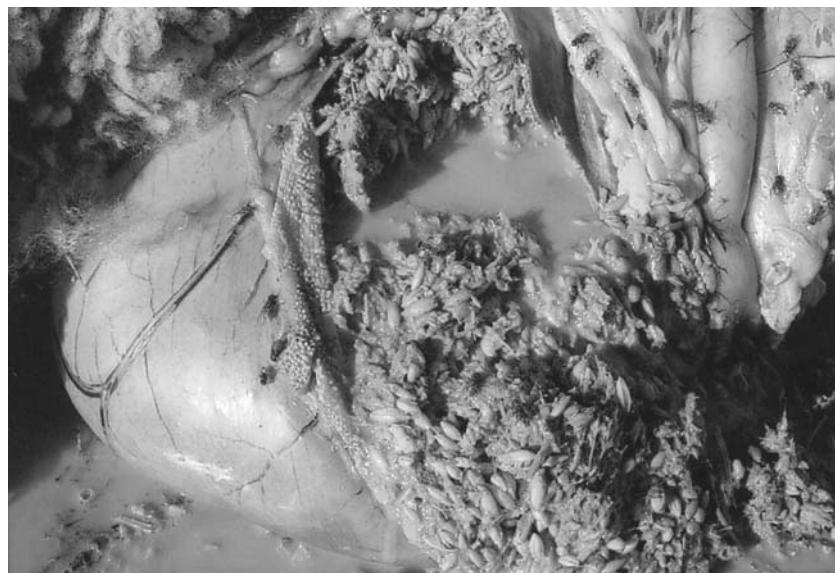


Figure 15. Acidosis caused by sudden intake of a large amount of cereal grain

amounts of roughage (10–30 %) will help to prevent acidosis. Roughage stimulates the production of saliva which buffers the acidity in the rumen and also stimulates rumen movement ensuring adequate mixing of feed and microbes.

Acidosis commonly occurs when lambs are first introduced to grain or there is a sudden intake of excessive amounts of grain. Affected lambs show a lack of appetite, depression, weakness, a soft or watery scour with a sweet-sour odour, rapid breathing and eyes that are set well back in the head. They may stand quietly, walk with a stagger and bump into objects, or go down. Death usually occurs in one to three days. Wheat is the most dangerous grain, with lupins, peas and oats the safest.

*Treatment:* Treatment costs can be expensive and in severe cases treatment is unsuccessful. Drenching with 15 g of sodium bicarbonate, magnesium oxide or sodium bentonite can overcome acidosis in individual animals. Water should be restricted for 12–24 hours and affected lambs should have access to good quality hay, although appetite may not return for 12–48 hours. Reintroduce lambs to grain again over a 10-day period.

*Prevention:* Introduce grain to the lambs slowly as described in Chapter 4. Hungry or unaccustomed animals should be prevented from having access to large amounts of grain.

### Pulpy kidney (enterotoxaemia)

This is caused by the sudden proliferation in the intestine of the specific strain of clostridial bacteria known as *clostridium perfringens, type D* which produces toxins. Usually the heaviest and best lambs are found dead, with head arched back. There will be signs of kicking and froth at the mouth. The carcase 'blows up' and decomposes rapidly and the skin will have a purple colour.

A post mortem conducted more than one hour after death will show the kidneys to be lighter in colour than normal and jelly-like. The small intestine is very distended with gas, even at the time of death.

*Treatment:* Reduce grain intake and vaccinate. Vaccination is the only long-term effective method of control. Turning lambs into a grass paddock at night coupled with the forced exercise obtained by moving them has been reported to produce good results.

*Prevention:* The only fully effective prevention is to vaccinate the lambs twice before commencing feedlotting. If the lambs are purchased and their vaccination history cannot be obtained, two vaccinations four to six weeks apart should be given to ensure protection. If the history of the lambs is known and they have received two vaccinations according to manufacturer's recommendations it is still recommended

that they be given a further vaccination if the last vaccination was more than six months previously.

### **Pink eye (contagious ophthalmia or conjunctivo-keratitis)**

This is caused by specific bacterial infections and aggravated by dust. The eyeball of infected animals becomes white or pink, and if infected in both eyes the animal may be blind. Affected animals lose weight and may die of thirst if unable to find water. Recovered animals have resistance for varying lengths of time, usually longer than nine months. In a feedlot situation, once an animal recovers it should not become infected with pink eye again.

*Treatment:* Many proprietary ointments are available but recent research indicates that treatment may have little effect on the course or severity of the disease.

*Prevention:* Reduce dust by carefully selecting the site for the feedlot. Remove lambs showing symptoms (blindness in both eyes) and place them on to good feed out of the feedlot. Check all eyes for grass seeds when introducing animals to the feedlot.

### **Scabby mouth (Orf)**

Scabby mouth, or Orf, is a viral disease that particularly affects lambs but can affect sheep at any age. As the name suggests the condition leads to scabs around the mouth as well as other areas of exposed skin.

Spread in a flock through direct contact with infected sheep or infective material is rapid and can lead to a large proportion of the flock becoming infected. Death rates amongst infected sheep are generally relatively low. Clinically, the disease causes ill-thrift and varying levels of pain. Economically, the disease assumes great importance in the rejection of live sheep exports. Furthermore, the disease is zoonotic. In other words it can infect people involved in the handling of sheep.

*Treatment:* In the advent of an outbreak all affected sheep should be isolated and the remainder of the flock vaccinated. There is no specific treatment available and generally the disease will clear up in about three to four weeks. Infected animals should be provided with palatable feed and treated to prevent blowfly strike.

*Prevention:* Scabby mouth can be effectively prevented through the vaccination of lambs.

### **Vitamin A deficiency**

This occurs when lambs are fed for longer than six months without access to green feed or lucerne hay. The symptoms shown are night blindness, eye discharge, and poor growth.

**Treatment:** Either vitamin A injections or supplements can be given to animals showing signs of vitamin A deficiency.

**Prevention:** Ensure that adequate lucerne hay is fed in the diet. Alternatively, a vitamin A injection can be given every three months, allowing the animals to store enough vitamin A in the liver to last the duration of their time in the feedlot.

## Pneumonia

This is caused by bacterial infections and aggravated by dusty conditions. Lambs show signs of nasal discharge, coughing, ill-thrift or sudden death.

**Treatment:** Antibiotics can be used to successfully treat some types of pneumonia.

**Prevention:** Site the feedlot in a dust-free environment, eliminate competitive and climatic stresses (such as annoyance by dogs and the effects of sudden weather changes) and provide a well-balanced diet.

## Coccidiosis

Coccidiosis is caused by a microscopic protozoan parasite known as *Eimeria* spp that is found in the intestinal wall of affected sheep. Coccidiosis usually occurs when lambs are overcrowded, kept in one area, and fed in a way in which food can be contaminated with droppings. In feedlots lambs are most susceptible to coccidiosis soon after their introduction into the feedlot due to them not having any previous exposure to the organism. Stress due to poor nutrition or worm infestations increases susceptibility. Affected animals develop a dark, watery, sometimes blood-tinged scour, and strain to pass faeces. They may recover, or lose weight and die after several days.

**Treatment:** If suspected, separate infected lambs from the mob and have the diagnosis confirmed by a veterinarian, who will prescribe a treatment regimen. Treatments are no longer available over the counter.

**Prevention:** As all lambs are likely to carry some coccidiosis, prevention relies on avoiding stress and a wet, overcrowded feeding environment.

# 7

## Case study

### Rutherglen Research Institute lamb feedlot

#### Introduction

A study was completed at Rutherglen Research Institute in October–November 2000 to gain information on growth rates, rations and practicality of using self-feeders to finish lambs on grain. The study was designed so that producers could duplicate the



Figure 16. View of site for lamb feedlot trial

system using minimal equipment and labour. The lambs for the trial were bred on the Institute and individually tagged at birth. Their dam, sire and birth date were known.

## Lambs

Six hundred second-cross five-month-old lambs (Border Leicester × Merino ewes mated to either Poll Dorset or White Suffolk sires) were allocated to 50 lambs per plot. The average weight of the lambs was 35.5 kg but ranged from 22 kg to 50 kg with an age range of five to six months. The lambs were shorn and drenched for internal parasites two weeks prior to allocation to treatments in the feedlot. They were fed an introductory 70:30 mixture of oats:lupins traileted on the ground for two weeks prior to entry to the feedlot. The amount fed increased from an initial amount of 200 g/hd/day to 700 g/hd/day just prior to entering the feedlot. They had been vaccinated with a 6-in-1 vaccine at marking and weaning and were therefore not vaccinated pre-entry.

## Feedlot site

A 9.9-ha paddock was fenced to provide 12 half-hectare plots (Figure 16). The paddock had very little feed as it had been cropped the previous year and the stubble heavily grazed prior to the lambs entering the feedlot. Shade cloth (approximately 2 m x 2 m) suspended from four posts provided shade. The shade was sited in the middle of the plots. Water was provided in troughs at the corner of each plot. Water troughs were cleaned daily.

## Feeding equipment

Each plot had one stock feeder. The trial utilised two types; a Cowra lick feeder and a cattle lick feeder. A problem encountered with the cattle feeder was that the lambs



Figure 17. Mineral mix trough

would stand or lie in the trough, thus spoiling the feed by contaminating it with faeces. A simple solution to this problem would be to weld a bar over the trough to prevent the lambs from standing in it. A small covered trough feeder was placed at the rear end of each of the plots for the salt/limestone mixture (Figure 17).

## Rations

Four rations with similar protein and energy contents but with different protein sources were prepared (Table 11 and 12). The energy level averaged 10.5 MJ ME/kg DM, and protein level averaged 15.4%. The control ration was made up of oats, triticale and lupins. Over the first week, the 70:30 oats:lupins ration was gradually changed to the final trial rations. A commercial fertiliser grade urea was used to increase the protein content in Ration 2.

Bentonite (2%) and sodium bicarbonate (1%) were added to each ration as preventatives against grain poisoning. A bale of lucerne hay (approximately 23 kg) was fed to each plot every second day during the trial (bales were opened and fed on the ground). A 50:50 mixture of salt and limestone was provided ad libitum in small feeders placed near each water trough.

## Mixing

Rations were mixed by augering the grain into a grain bin and then from the grain bin to the feeder. The urea, bentonite, bicarbonate and meals were weighed individually, mixed together thoroughly and then this mixture was shaken into the auger as the grains were being augured into the grain bin. The grain bin had scales on it enabling weighing of individual portions. These rations were then transferred by auger into the feeders.

**Table 11. Composition and cost<sup>1</sup> of rations**

	Ration 1 Control	Ration 2 Urea	Ration 3 Canola	Ration 4 Sunflower
Triticale, %	25.5	34	25.0	34.5
Oats, %	46.5	51	48.5	41
Lupin, %	25	11	–	–
Urea, %	–	1	–	–
Canola meal, %	–	–	23.5	–
Sunflower meal, %	–	–	–	22.5
Bentonite, %	2	2	2	2
Sodium bicarbonate, %	1	1	1	1
ME, MJ/kg DM	10.96	10.77	10.53	10.92
Crude protein, %	15.2	15.3	15.6	15.3
Cost, \$/tonne	168.85	159.05	191.78	186.71

<sup>1</sup> Grain prices were \$162, \$120, \$244, \$550, \$330, \$330, \$289 and \$550 per tonne for triticale, oats, lupins, urea, canola, sunflower, bentonite and bicarbonate respectively.

**Table 12.** Dry matter, crude protein and metabolisable energy of the feed ingredients used in the rations

Item	Dry matter	ME, MJ/kg DM	Crude protein%
Triticale	90.9	12.7	15.0
Oats	91.6	10.0	7.6
Lupins	91.6	12.3	31.4
Urea	100	0	291
Sunflower meal	86.4	9.1	32.6
Canola meal	92.4	12.3	33.5
Bentonite	100	0	0
Bicarbonate	100	0	0

### Trial length

The lambs were fed for 42 days in the feedlot and then slaughtered at a commercial abattoir.

### Results

Growth rates and hot standard carcass weights were not significantly different between the different treatments (Table 13). There was a difference in GR scores with lambs in the control groups having higher GR scores than lambs in the urea and sunflower meal treatments. The average daily gain of the lambs was between 241 and 271 g/day. The urea diet was the cheapest of all the rations and resulted in producing the most economical liveweight gain.

**Table 13.** Liveweight (LW), average daily gain (ADG), feed conversion ratio (FCR), hot standard carcass weight (HSCW) and GR tissue depth of lambs fed one of four grain rations for six weeks

Experimental diets	Ration 1 Control	Ration 2 Urea	Ration 3 Canola	Ration 4 Sunflower
Initial LW, kg	35.3	35.6	35.3	36.0
Final LW, kg	46.5	46.5	45.3	46.8
ADG, g/day	271	269	241	260
Intake, kg/day: Grain	1.70	1.61	1.71	1.57
Hay	0.25	0.26	0.24	0.24
FCR, g/g	7.32	6.72	8.04	6.65
HSCW, kg	20.2	20.0	19.9	20.3
DP <sup>1</sup> , %	46.9	47.1	47.5	47.6
GR, mm	10.6	9.9	10.2	9.7
Cost <sup>2</sup> , (\$)/kg LW gain	1.22	1.07	1.17	1.46

<sup>1</sup> Dressing percentage calculated from the HSCW and liveweight of lambs after being off feed for 12 hours.

<sup>2</sup> Calculated by dividing the cost of the feed consumed by the amount of liveweight gain in the 42 days.

## Discussion

Changing the protein source but keeping the same protein and energy levels in the ration did not significantly change average daily gain or carcase weights. The choice of the ration would therefore depend on economics. The urea ration was the cheapest as a significant proportion of the protein was provided by urea. Protein is normally the most expensive part of a ration. In this example 1% urea (at \$550/tonne) was substituted for 14% lupins (\$244/tonne) which considerably decreased the cost of the ration.

The lighter lambs at the start of the trial grew on average at the same rate as the heavier lambs and were therefore still lighter at the end of the trial. Obviously lighter lambs would have to be fed for a longer period to achieve export market weights. In a commercial operation, a much tighter spread of liveweights would be necessary to ensure that all finished lambs meet market specifications at a similar time.

The objective of this trial was to feed the lambs for a period of six weeks only. In a commercial situation this would be economically feasible if the initial liveweight was set at a minimum of 35 kg. Lighter animals than 35 kg would not meet export market specifications in a six-week time period.

## Conclusions

Average growth rates of 250 g/day can be achieved with second-cross lambs fed from self-feeders in small paddocks. Feeds can be mixed through augers without the use of expensive mixing equipment. Provision of supplements and urea can be achieved by adding these ingredients to the grain whilst the grain is being augered into the delivery truck. Hay can be fed every second day but the preferred option would be to use a hay rack to ensure a constant supply of roughage.



# Appendix 1

## What is LAMBPLAN?

LAMBPLAN is a genetic information system for the sheep, lamb and goat industries based at the University of New England in Armidale, NSW. LAMBPLAN and Merino Genetic Services provide seedstock breeders and prime lamb producers with genetic information on economically important production traits.

Feedlot producers may specialise in any of the following production systems:

- Producers that purchase store lambs to finish in the feedlot, or
- Producers that purchase prime lamb dams and terminal sires to breed their own lambs and finish them in a feedlot, or
- Producers that purchase terminal sires and have a self-replacing flock and breed their own prime lamb dams (Merino or first-cross ewes) and finish the wether portion and/or first or second-cross lamb progeny in the feedlot.

Depending on the type of production system, a variety of LAMBPLAN Estimated Breeding Values (EBVs) can be used by feedlotters to turn off superior lambs.

## How does the LAMBPLAN system work?

LAMBPLAN measures the genetic potential of each animal in participating flocks by calculating EBVs for all commercially important traits. This calculation is done using information on the animal's performance, supplied by the seedstock breeder and accredited operators, related trait performance and the performance of their relatives. All this information is entered into the LAMBPLAN database and analysed to provide the producer with important production information.

## What can LAMBPLAN offer to producers?

### Key benefits

By using LAMBPLAN information to select terminal sires or prime lamb dams for your operation, you can produce prime lambs that exhibit the traits that you wish to emphasise. This makes it easier to tailor your products to specific markets such as the heavy lamb turned off from feedlots. Producing carcasses that meet these specifications will enable producers to access top-end markets adding value to your product.

## What EBVs are applicable to the lot feeding of lambs?

Producers that *purchase or breed lambs for finishing* in the feedlot should ensure the lambs have been bred from stock whose own LAMBPLAN EBVs are appropriate for a feedlotting system. Genetically superior sires and dams produce superior lambs through extra weight, fewer over-fat lambs and improved carcass conformation and dressing percentage. They should have positive EBVs for growth (weaning and post weaning weight) and muscle and negative EBVs for fat.

Additionally, producers that purchase or breed their own prime lamb dams should ensure that the ewes have been selected and bred using superior maternal EBVs for maternal weaning weight and reproduction.

Below are details of these traits and the various ages that the genetic value can be estimated for them.

### Weight

- Birth Weight EBVs provide the producers with the opportunity to maintain or reduce birth weight to allow ease of lambing. One of the pressures being placed on producers is to produce large, lean lambs and this has resulted in an increase in birth difficulties because of an increase in size. LAMBPLAN can provide birth weight EBVs to help control this problem.
- Maternal Weaning Weight EBVs are also available describing the combination value of milking and mothering ability.
- Weaning Weight EBVs are an invaluable source of information for producers as it allows performance to be measured whilst the animal is on its mother. It also allows producers to better select for growth from birth to weaning ages and for those who are in the production of trade sucker lambs, the faster the growth, the faster they finish.
- Post-Weaning Weight EBVs are very important for the heavy weight lamb producer. This value will allow for selection of sires that will ensure fast growing heavy lambs.
- Yearling Weight EBV is important if lambs are 10–12 months of age at turn-off.

### Fat

- Post-weaning fat gives a strong indication of the level of fat the animal will be carrying during its growth period. The EBV is used in conjunction with the post weaning weight for the production of large, lean lambs (55 kg LW).
- Yearling fat is used for those producers who grow their animals out to a heavier weight. This EBV can be used in conjunction with the yearling weight for those

looking to produce a heavier weight animal that may be sold as an older lamb or used for joining.

- Lambs on a grain fed diets tend to deposit more fat than lambs on a pasture fed diet. For this reason it may be important to place more pressure on the fat EBV to ensure lambs are not over-fat at turn-off weight.

## Muscle

- Post-weaning muscling provides the breeder with the opportunity to increase the amount of muscle being carried by the lamb. A negative EBV for this trait will see an animal carrying less muscle than an animal with a positive EBV for muscle, at a constant weight.
- Yearling muscle is useful for those producers looking to grow their lambs out to maximum weight as in a feedlot situation or for those producers in areas that require a little longer finishing lambs.

## Reproduction

- Reproduction EBVs describe an animal's genetic potential for the number of lambs born and weaned. These EBVs are expressed as a percentage.

LAMBPLAN Selection Indexes can also be utilised.

In addition to EBVs for individual traits, LAMBPLAN flocks and their clients have access to a range of selection indexes. An index is a single figure that ranks animals for their suitability to a particular breeding objective. They are calculated by applying weightings to the EBVs and take account of trait heritability and genetic correlations with other traits of interest.

**Carcase Plus:** 60% of the emphasis is placed on weight or increasing growth rate, 20% is placed on improved leanness or reduced fatness and 20% is placed on greater muscling. The Carcase Plus index is calculated using post-weaning information which has been shown as the age where the majority of lambs are being turned off. This selection index ranks animals on their ability to breed heavy, lean and well muscled progeny suitable for the elite lamb market – lambs that are greater than 20 kg carcase weight with a fat score of 2–3 and ideal conformation.

**60:20:20:** is similar to the Carcase Plus index. However, it is based on yearling information rather than post-weaning information. This index is of particular interest to those people who take a little longer to finish lambs.

Outlined is an example to show how LAMBPLAN could assist producers to select terminal sires using LAMBPLAN EBVs and indexes.

## Example

The following example is what EBVs figures a ram breeder can provide to commercial buyers

LAMBPLAN ID	PWWT	PFAT	PEMD	Carcase +	60:20:20
160000200101001	5.5	-1.5	1.0	154.6	150.9

Here, sire 010001 comes from the Poll Dorset breed (breed code 16). He has a Post-Weaning Weight (PWWT) EBV of 5.5 which means that his progeny (the commercial lamb) will be 2.75 kilograms heavier at 8–10 months ( $\frac{1}{2}$  the genes come from the sire, hence  $5.5 \text{ (PWWT)} \times 0.5 = 2.75$ ). Following this equation through the above table, the progeny will be 0.75 mm leaner at the GR site at 60 kg in weight. The progeny will also have an eye muscle depth that is 0.5 mm deeper at the C site at 60 kg. The combination of less fat and better muscling results in higher yielding carcasses.

Carcase Plus index combines the EBVs for growth (60%), leanness (20%) and muscling (20%) into a single value. This ram is well balanced, having higher than average growth, being leaner than average and having better muscling. As a result he is well suited for both trade and export markets, particularly where lambs are sold OTH and penalties for poor conformation or excessive fatness are high. 60:20:20 places the same emphasis on growth, leanness and muscling but on yearling EBVs rather than post weaning EBVs.

For more information about LAMBPLAN please contact the LAMBPLAN office on (02) 6773 2948 or visit the LAMBPLAN website [www.lambplan.com.au](http://www.lambplan.com.au).

The following table provides a guide to using Terminal Sire EBVs for Trade and Export Market and Ewe Types.

**Table 14. Terminal Sire EBV Guidelines for Trade and Export Markets and Ewe Types #**

Lamb carcase weight (CW) and ewe type	EBV Specifications and Reasons for Recommendation			
18–22 kg CW lambs from XB ewes	PWWT 4–6 +	PFAT < -0.5	PEMD > 0	Carcase Plus Index 140 +
Note: If PWWT is > 8 then PFAT range should be between -0.5 and 0.				
Rams with higher post-weaning weight EBVs will produce lambs with faster growth rates and will have greater carcass weights at given ages. As new season lambs from first-cross ewes are usually fatter, rams should have average to below average EBVs for fat. However, if sires EBVs for growth are high then pressure on fat should be lower.				
18–22 kg CW lambs from Merino Ewes	PWWT 4–6 +	PFAT < 0	PEMD > 0	Carcase Plus Index 140 +
In general growth rate should be slightly higher and pressure on fat lower, particularly if the environment is such that the season is shorter. Emphasis on muscling should be moderate to high.				
24 kg + CW lambs from XB ewes	PWWT 6 +	PFAT < -0.8	PEMD > 0	Carcase Plus Index 154 +
Getting 2, 3 or 4 fat score 24 kg-plus lambs is a challenge. Sires with negative EBVs for fat will produce leaner lambs. Selecting sires with higher growth rate and negative EBVs for fat will produce higher yielding lambs. Please note that animals with higher EMD EBVs tend to have higher fat EBVs. Therefore pressure placed on EMD EBVs will depend on WT and fat EBV figures.				
24 kg + CW lambs from Merino ewes	PWWT 6 +	PFAT < - 0.6	PEMD > 0.2	Carcase Plus Index 140 +
In general EBVs for fat do not need to be as low as for XB ewes. However it is important that you look at your feedback sheets as there is significant variation in the genes for fatness and growth amongst merino ewes. In general, Merino ewes may also be slightly poorer muscled so a little more emphasis on muscling should occur.				

Note: If lambs are 10–12 months of age at turn-off then consideration could be given to using yearling EBVs, such as YWT, YFAT, YEMD, and the 60:20:20 index based on yearling EBVs.

# These are general guidelines and breeders should make adjustments for their personal situation and consult with their ram breeders to determine the most appropriate sire selection.



# Appendix 2

## Dressing percentage

Dressing percentage is the proportion of the lamb retained after slaughter as carcase (meat, fat and bone). Actual dressing percentages are calculated using the carcase weight and liveweight.

## Factors that affect dressing percentage

Fat score. Lean lambs have lower dressing percentages than fat lambs (Table 15).

**Table 15. Dressing percentages for each fat score**

Fat score	Dressing Percentage
1	41
2	43
3	45
4	47
5	49

Note: These guidelines refer to second-cross lambs, 5 cm fleece and three hours off feed.

- 1 Time off feed prior to weighing. Dressing percentage increases with the amount of time off feed (Table 15).

**Table 16. Adjustments to dressing percentage for time off feed**

Time off feed	Add to dressing percentage
0–3 hrs	0
4–5 hrs	+ 0.5
6–8 hrs	+ 1
9–12 hrs	+2 to 3
13–24 hrs	+ 3.5 to 4.5

- 2 Feed conditions. Dressing percentage will vary  $\pm$  3 percentage points due to feed/grazing conditions. Decreasing feed quality decreases the dressing percentage as higher roughage diets have a slower release of gut fill.
- 3 Unweaned/weaned. Weaned lambs may dress up to 2 percentage points lower

than unweaned lambs of the same weight and fatness.

- 4 Sex. Wether lambs may dress 0.5 of a percentage point less than ewe lambs of the same weight and fatness.
- 5 Breed. Border Leicester/Merino, Bond, Corriedale and Merino lambs will generally dress 1.5 to 3.5 percentage points less than second-cross lambs.
- 6 Skin weight. This will depend on the length and type of wool, ie heavy or light cutting. Freshly shorn lambs and lambs with short wool will have a higher dressing percentage than woolly lambs. If 75 mm skin is just wet to shear (0.2–0.5 kg of water), subtract 0.5 percentage points from the dressing percentage; if thoroughly saturated (1–2 kg of water) subtract 1 or 2 percentage points from the dressing percentage.
- 7 Carcase Trim. To calculate a non-standard trim (kidney/kidney knobs retained) add 2 percentage points to the estimated dressing percentage. Heavy trimming will reduce dressing percentage.

# **Appendix 3**

## **Websites of interest**

**State Departments of Agriculture:**

**Department of Primary Industries (Victoria)**

[www.nre.vic.gov.au](http://www.nre.vic.gov.au)

**New South Wales Agriculture**

[www.agric.nsw.gov.au](http://www.agric.nsw.gov.au)

**Queensland Department of Primary Industries**

[www.dpi.qld.gov.au](http://www.dpi.qld.gov.au)

**Department of Agriculture – Western Australia**

[www.agric.wa.gov.au](http://www.agric.wa.gov.au)

**Department of Agriculture, Fisheries and Forestry – Australia**

[www.affa.gov.au](http://www.affa.gov.au)

**CSIRO**

[www.csiro.au](http://www.csiro.au)

**MLA**

[www.mla.com.au](http://www.mla.com.au)

**Kondinin Group**

[www.kondinin.com.au](http://www.kondinin.com.au)

**Sheepmeat Council – Sheep industry news**

<http://farmwide.com.au>

**Flockcare**

[www.ausmeat.com.au/programmes/flockcare/](http://www.ausmeat.com.au/programmes/flockcare/)

**Lambplan**

[www.lambplan.com.au](http://www.lambplan.com.au)

